

SOLVE II Mission Readiness Review

Dec 18, 2002

SOLVE II Balloon Campaign Overview

SOLVE II Balloon Investigations

Large payloads: Toon/JPL MkIV and in situ Ozone

early Dec and late Mar/Apr (plus ILAS II Val Apr03)

solar occultation

1200 lbs gondola

launch by CNES from Esrange

to 32 km (6.5 mb)

ground obs Jan-Mar

Sondes: Deshler/U Wyo aerosol

3 flights in Dec, Jan (plus PSC payload)

Voemel/CU/CMDL ozone, water

15 flights

Kiruna, Sodankyla, Lauder NZ (sunrise)

Rocket: Schmidlin/WFF temp

15 flights, late Jan

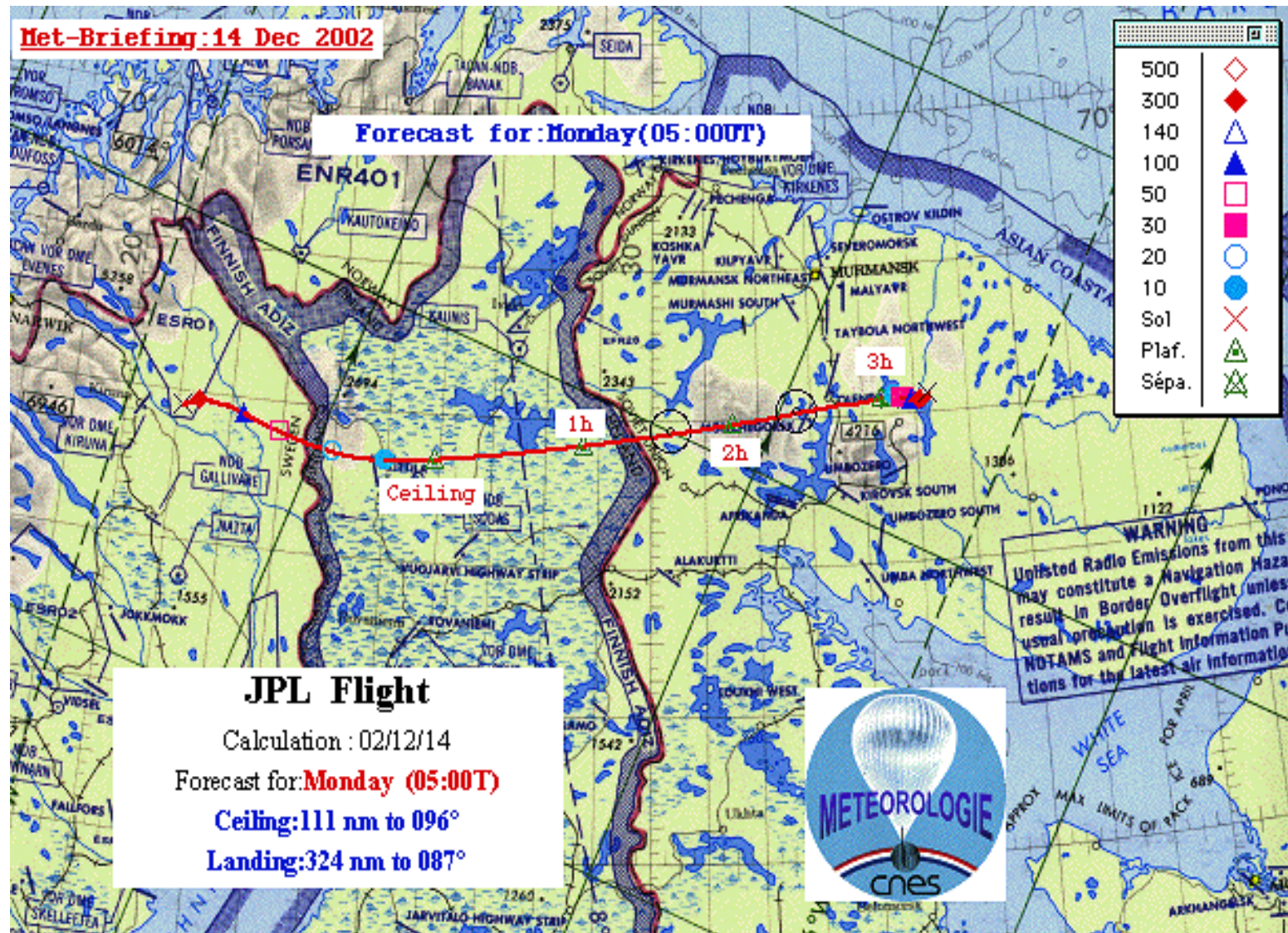
SOLVE II Balloon Operations

Large payload: Toon/JPL MkIV and in situ Ozone

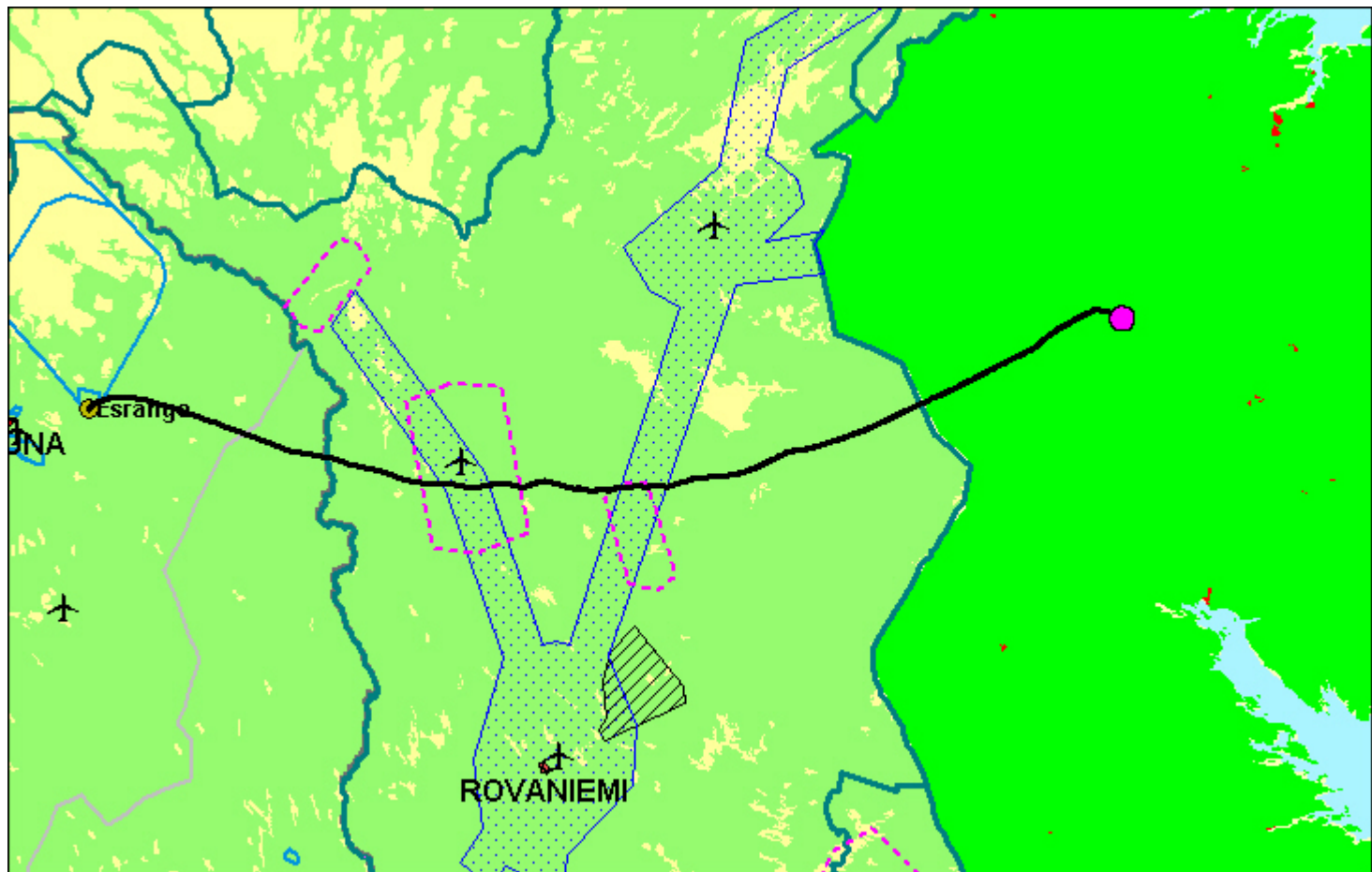
- Launch arrangements being handled by NSBF, the US Balloon Program Contractor
- Flights coincident with SAGE III overpasses
- Flights not near vortex edge: high winds, species gradients
- Dec launch by CNES
 - Contracted by NSBF
 - CNES has permission for landing in Russia
 - Actual flight on Dec 16: 5 hours, landed 100 km SW of Murmansk.
 - Russian recovery and return of payload (ETA Fri/Sat)
 - FLEW: Dec 16, 2002. Successful sunrise profiles 12-32 km + in situ ozone.**
- March flight TBD
 - Optimum overpasses Mar 22-Apr 2
 - Rocket campaign closes Esrange for balloon flights Mar 27-Apr 15
 - Possible CNES schedule issues (cancelled ADEOS Val)
 - Possible NSBF/Esrange collaboration
 - NSBF launch unlikely: expensive, a lot of work for one flight

Sondes, Rockets: Launch arrangements made by individual PIs, not SOLVE II Project.

MkIV Planned Flight Trajectory



MkIV Flight Trajectory 2002-12-16



Winter 2002-3 Balloon Flights

	Dec	Jan	Feb	Mar	Apr
SOLVE2					
Large	MkIV			MkIV	
Sonde	aerosol-----				
		H2O/O3---			
Other	PSC	VINTERSOL/ENVISAT	ILAS-MkIV+		
	MIPAS	Match ozonesondes			
Rocket		Temp			

Vertical Aerosol Profiles with Wyoming Optical Particle Counters and Condensation Nuclei Counters

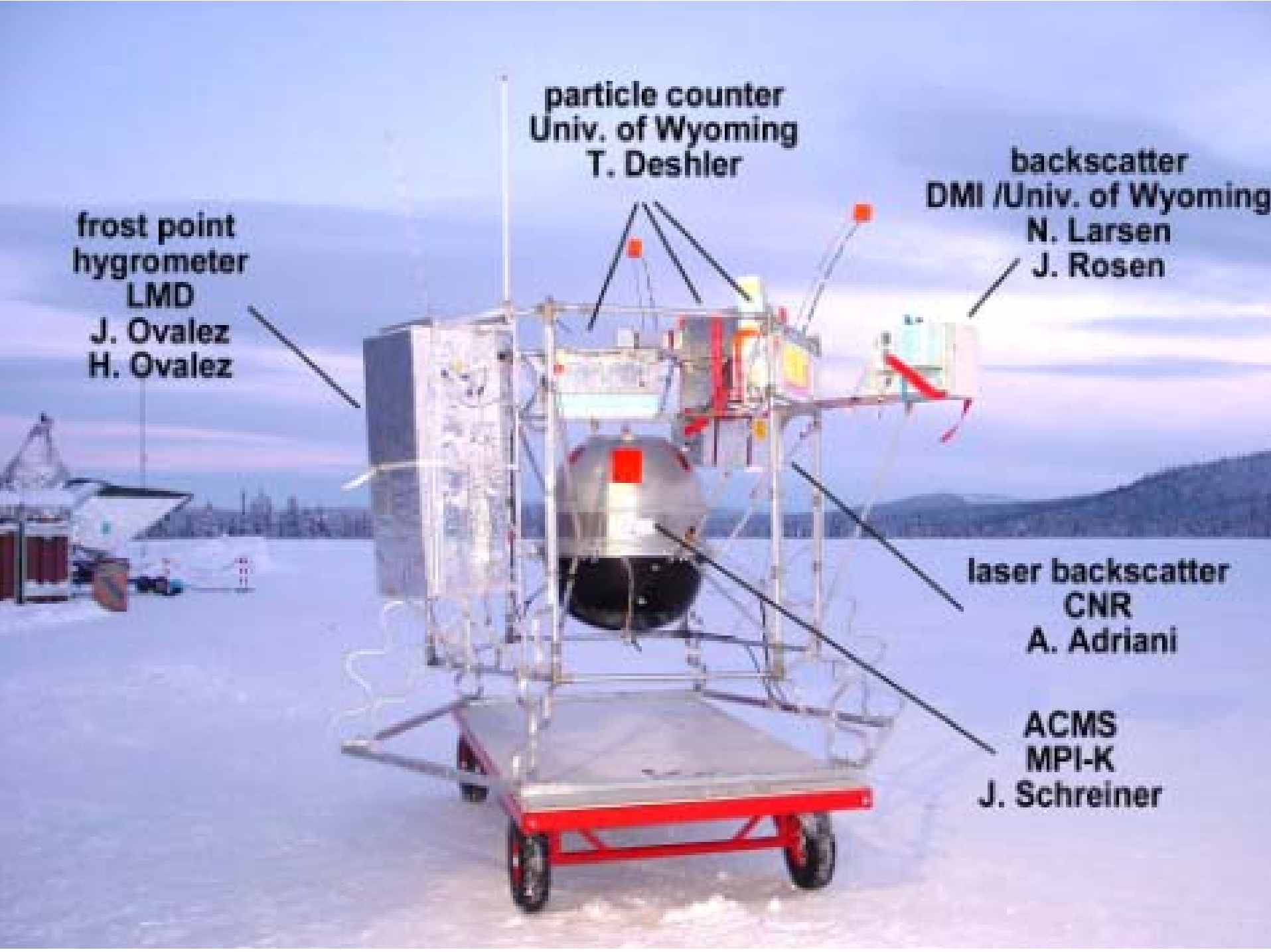
Terry Deshler

University of Wyoming

- **Aerosol size capability:**
 - **Condensation Nuclei (CN), $r \geq 0.01 \mu\text{m}$**
 - **Aerosol with radius $\geq 0.15, 0.19, 0.25, 0.30, 0.38, 0.49, 0.62, 0.78, 1.08, 1.25, 1.58, 2.00 \mu\text{m}$**
 - **Size channels are somewhat dependent on the particle index of refraction assumed.**
- **Concentration range:**
 - **$0.0006 - 30 \text{ cm}^{-3}$ for $r \geq 0.15 \mu\text{m}$**
 - **$0.006 - 2000 \text{ cm}^{-3}$ for CN**

Plans December 2002 - January 2003

- **SOLVE II** - Three vertical profiles of CN and particles $r > 0.15 - 2.0 \mu\text{m}$ in conjunction with SAGE III overpasses of Esrange 67.9°N , 21.1°E .
 - One flight has been completed on 3 December.
- **PSC analyses gondola** - comprehensive in situ measurements within polar stratospheric clouds, two flights. Measurements include:
 - Composition (MPI, Germany)
 - Size distribution (U Wyoming, USA, funded by NSF)
 - Phase (IFA, Italy)
 - Optical properties (IFA, Italy, DMI, Denmark)
 - Gas phase water vapor (LMD, France)
- These two flights have been completed on 4 and 6 December



particle counter
Univ. of Wyoming
T. Deshler

backscatter
DMI /Univ. of Wyoming
N. Larsen
J. Rosen

frost point
hygrometer
LMD
J. Ovaléz
H. Ovaléz

laser backscatter
CNR
A. Adriani

ACMS
MPI-K
J. Schreiner

Atmospheric Composition Measured by Solar Occultation Spectrometry

Geoffrey Toon, Bhaswar Sen, and Jean-Francois Blavier

Jet Propulsion Laboratory, California Institute of Technology
Pasadena, California, USA

Purpose of the MkIV balloon instrument:

- Validate satellite measurements.
- Validate atmospheric models.
- Trend Detection.
- Evaluate adequacy of laboratory spectroscopy.
- Evaluate technology improvements.

The JPL MkIV Interferometer

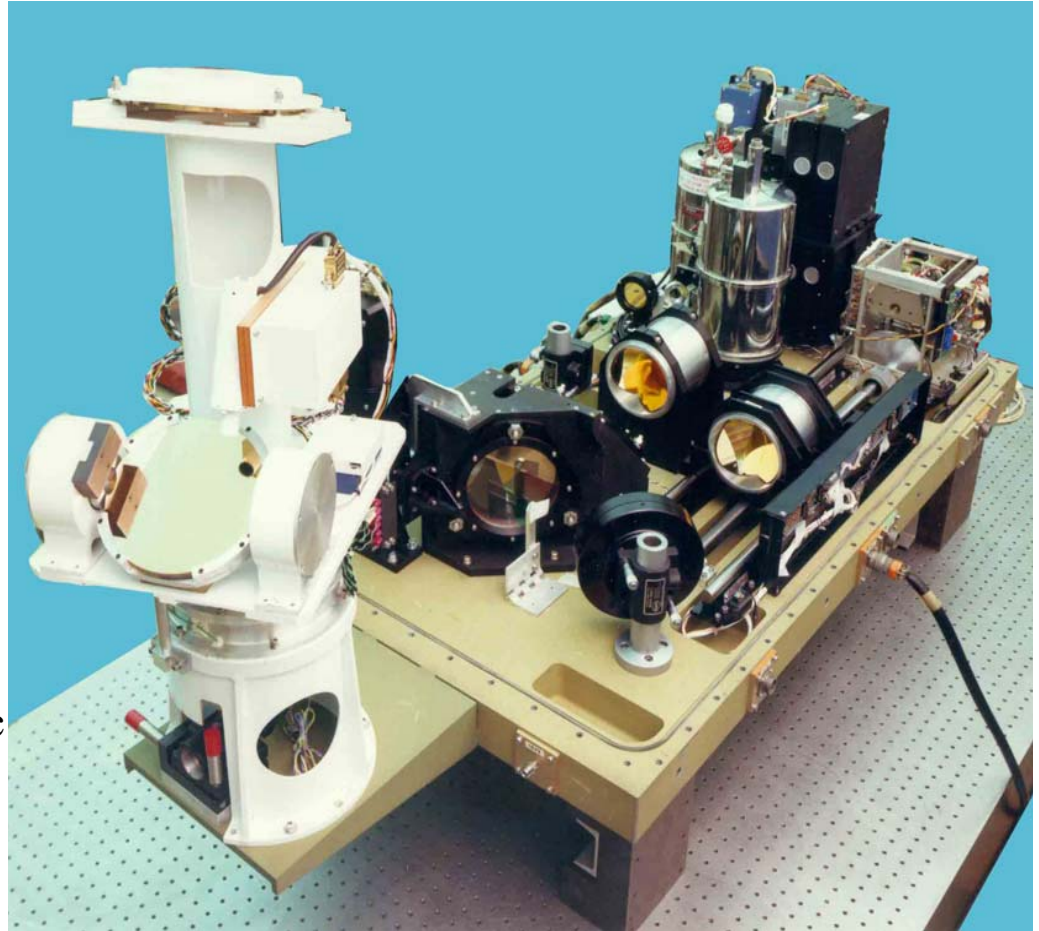
Built at JPL in 1984, following the ATMOS optical design.

Mass=200 kg, Size =1.5x1.0x0.8 m.

Parallel HgCdTe & InSb detectors simultaneously cover $650\text{--}5650\text{ cm}^{-1}$ with 0.008 cm^{-1} spectral resolution.

Over this wide mid-infrared interval over 30 different gases have spectral signatures, including H_2O , CO_2 , O_3 , N_2O , CO , CH_4 , N_2 , NO , NO_2 , HNO_3 , HO_2NO_2 , N_2O_5 , ClNO_3 , H_2O_2 , H_2CO , HOCl , HCl , HF , SF_6 , COF_2 , CF_4 , CH_3Cl , CH_2Cl_2 , CFCl_3 , CF_2Cl_2 , CCl_4 , OCS , HCN , C_2H_2 , C_2H_6 and many isotopic variants (e.g. HDO , CH_3D).

Has performed 13 balloon flights, 3 aircraft campaigns, and 878 days of ground-based observations.



MkIV Balloon Flight History

Date	Tangent Latitude (degrees)	Tangent Longitude (degrees)	Minimum Altitude (km)	Balloon Altitude (km)	Launch Site	Event
05-Oct-89	34.6	-105.7	13	37	New Mexico	Sunset
27-Sep-90	34.2	-106.0	10	36	New Mexico	Sunset
05-May-91	37.5	-111.8	15	37	New Mexico	Sunset
06-May-91	36.5	-103.0	15	32		Sunrise
14-Sep-92	35.2	-110.2	23	38	New Mexico	Sunset
15-Sep-92	35.3	-103.9	22	40		Sunrise
3-Apr-93	34.8	-115.5	17	37	California	Sunset
25-Sep-93	34.0	-109.4	4	37	New Mexico	Sunset
26-Sep-93	33.2	-100.4	11	38		Sunrise
22-May-94	36.6	-109.7	15	36	New Mexico	Sunset
23-May-94	36.3	-100.8	11	37		Sunrise
24-Jul-96	56.8	-101.0	11	24	Manitoba	Ascent
28-Sep-96	32.7	-113.0	6	38	New Mexico	Sunset
08-May-97	68.0	-147.0	8	37	Alaska	Sunrise
08-Jul-97	67.0	-148.0	8	32	Alaska	Ascent
09-Jul-97	65.0	-150.0	9	32	Alaska	Descent
03-Dec-99	64.0	19.0	6	34	Sweden	Sunset
15-Mar-00	69.0	27.0	12	30	Sweden	Sunrise



Advantages of High Resolution Solar Occultation Technique

Broad Spectral coverage (typically 650-5650 cm^{-1}):

Allows determination of aerosol composition and size distribution.

30+ different gases measured simultaneously in the same airmass, providing tight constraints on models.

A range of different strength bands are available for retrieval (strong for high altitude; weak for low).

High Signal-to-Noise Ratio and Resolving Power:

Able to measure weak absorptions of trace gases that lie close to much stronger lines.

Broad absorptions due to aerosol easily distinguished from narrow gaseous absorptions.

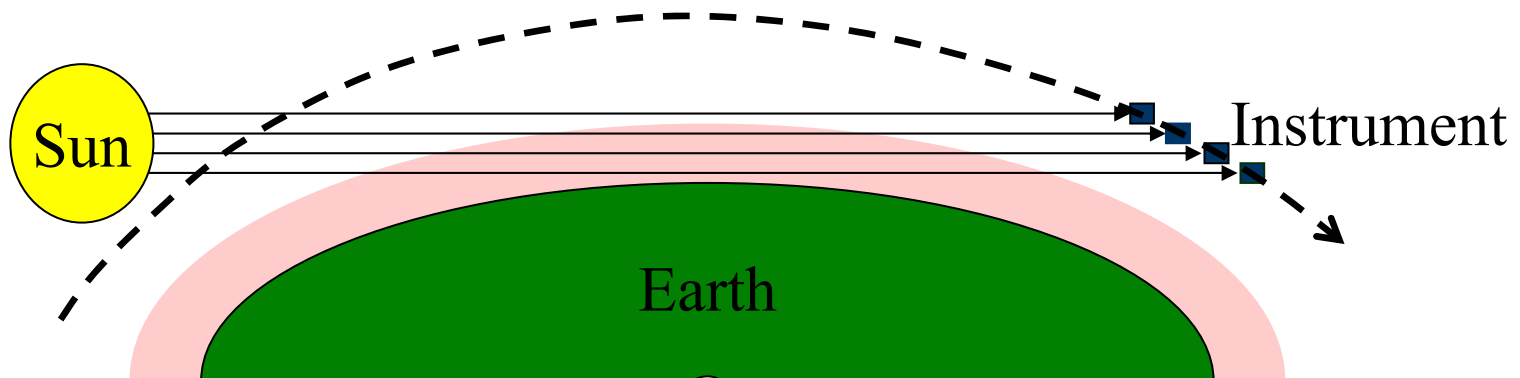
High Radiometric Calibration Accuracy:

Radiation thermally emitted by the instrument or atmosphere is negligible compared to Sun.

Ratioing limb spectra against exo-atmospheric spectrum removes solar & instrumental features.

Unambiguous photon path history:

All measured photons come from Sun and traverse the full limb path.



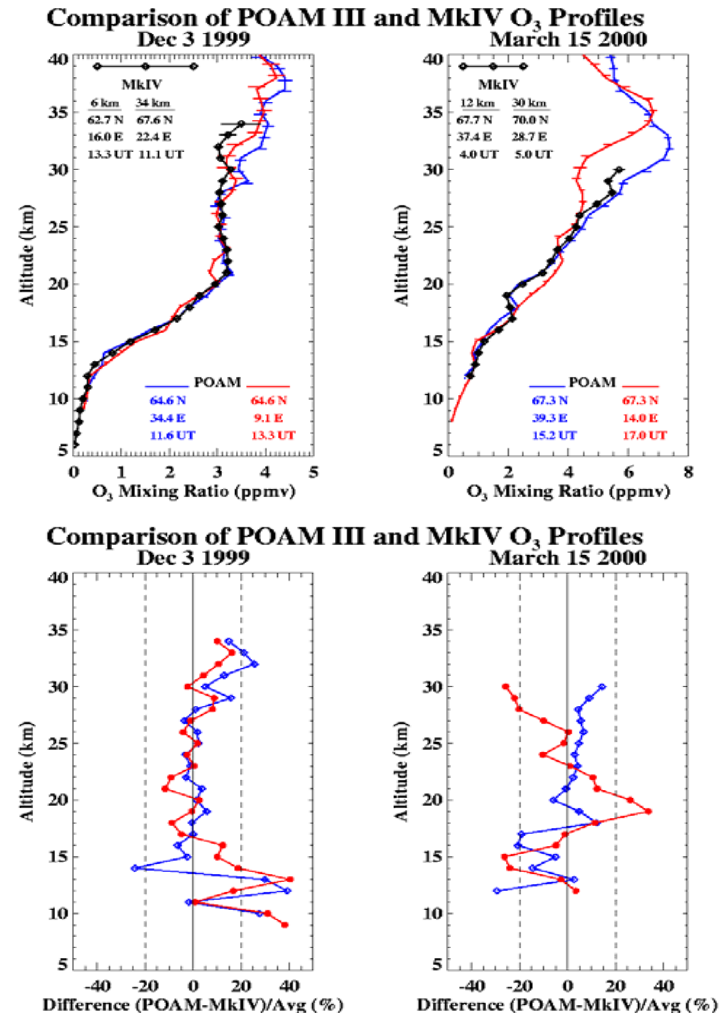
Validation of POAM III Ozone Measurements - MkIV

The MkIV payload made two flights during SOLVE. On the first flight, Dec 3, 1999, MkIV measured a sunset occultation, whereas the second flight on Mar 15, 2000 was a sunrise occultation.

POAM ozone profiles on Dec 3 show excellent overall agreement, within 10%, with the MkIV profile, deviating only at the very top of the profile and below 15 km.

POAM ozone profile at 39 N measured on Mar 15, sampling coincident air masses with the balloon, reproduces the detailed vertical structure in the MkIV profile almost exactly and are within 5 – 10 % at almost all altitudes, whereas the other POAM profile shows a very different vertical structure, consistent with fact that it is sampling very different air.

Lumpe *et al.*, *JGR*, in press, 2002.



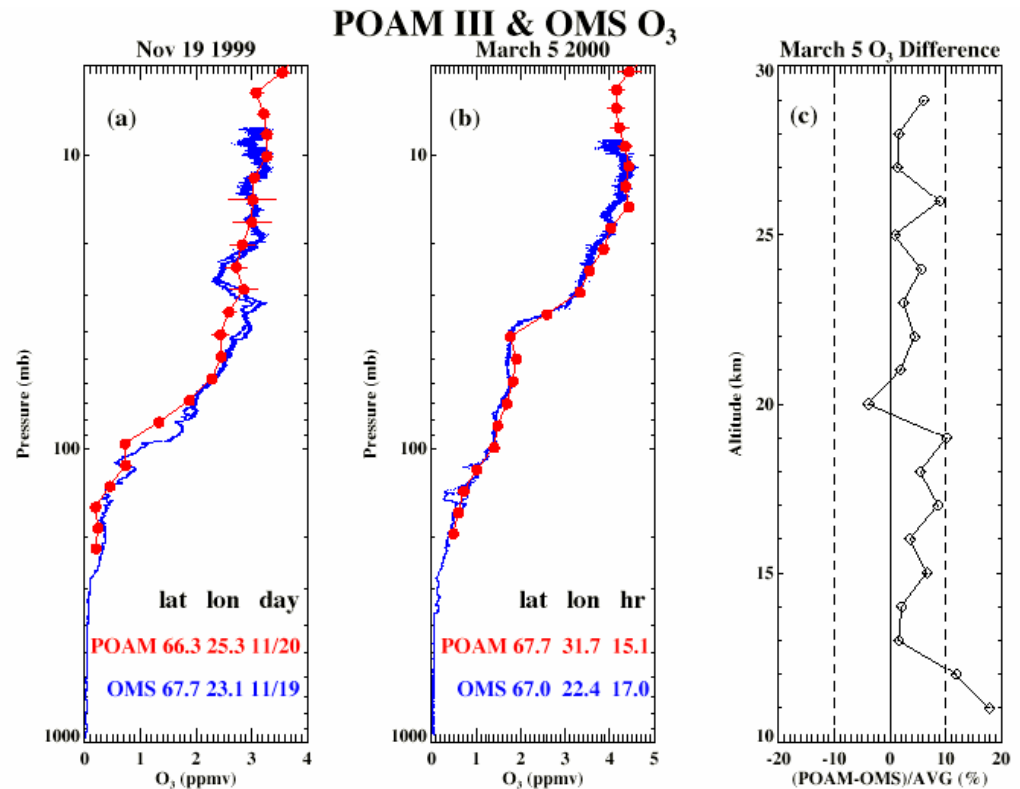
Validation of POAM III Ozone Measurements - in situ O_3

The JPL in situ Ozone Photometer (Margitan/PI and Sen/co-I) is flying as a piggy-back instrument with the MkIV for the SOLVE-II flights.

The Ozone Photometer made two flights during SOLVE as part of the OMS in situ payload.

Both flights show very good agreement with POAM III, although there was a 1-day difference for the November flight. For the close coincidence March flight, agreement is around 3-5% over most of the profile.

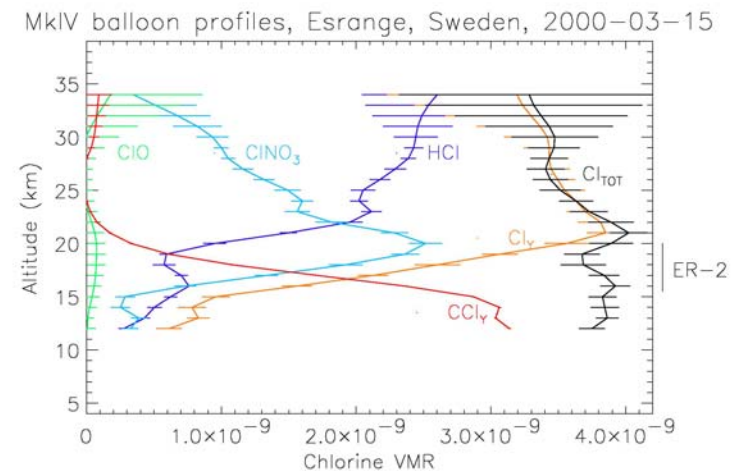
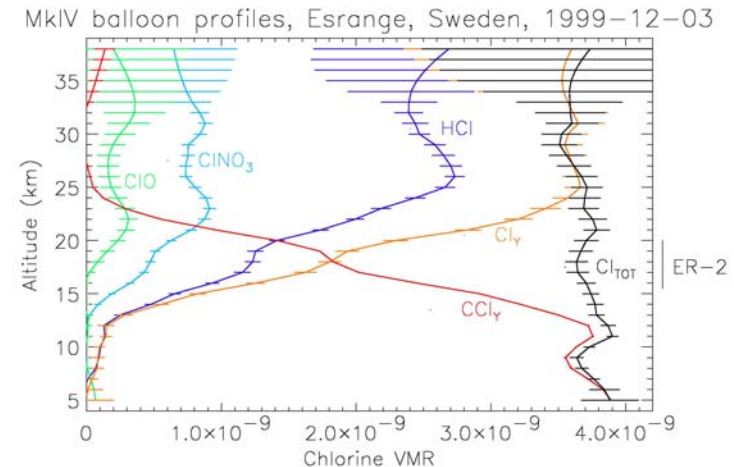
Lumpe et al., JGR, in press, 2002.



Measurements of Inorganic Chlorine During SOLVE

The upper panel shows that the total Cl_y was mainly HCl in Dec 1999.

The lower panel shows that chlorine partitioning was highly disturbed for the Mar 2000 flight. The HCl/Cl_y ratio decreased from 0.7 in Dec 1999 to 0.2 in Mar 2000. ClNO_3 was the predominant form of chlorine by mid-Mar 2000 (over 75% at 19 km altitude).

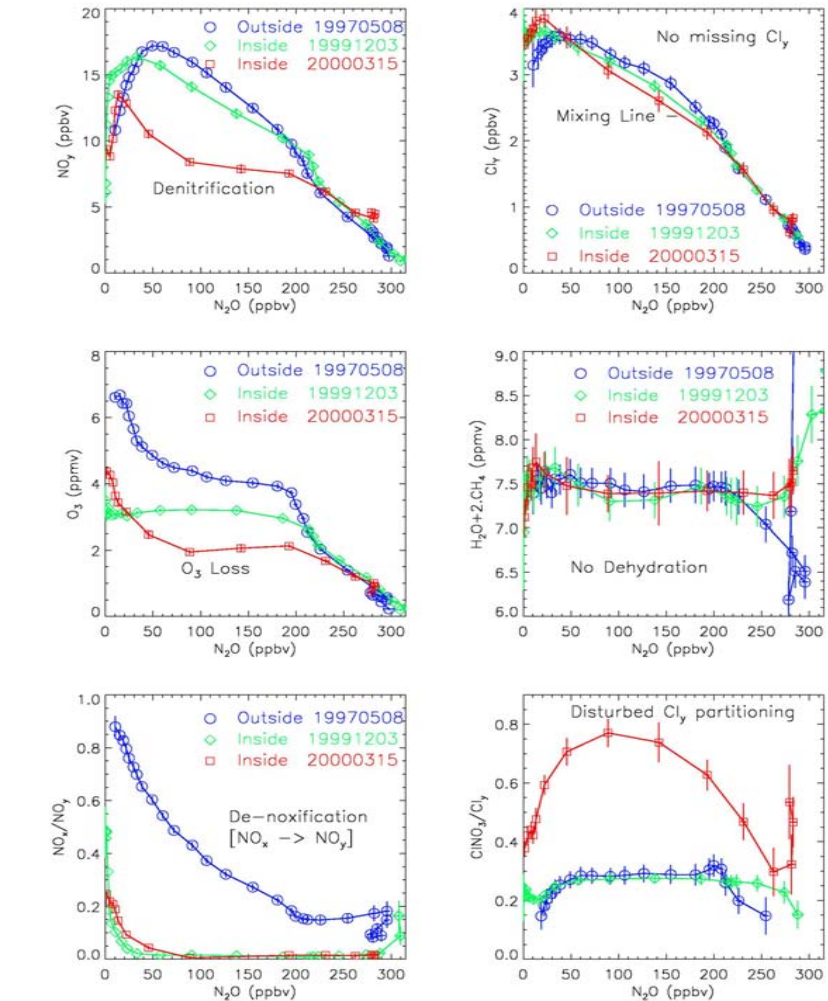


Summary of MkIV Measurements During SOLVE

The panels exhibit the relationship versus N_2O of NO_y , Cl_y , O_3 , $\text{H}_2\text{O} + 2\text{CH}_4$, NO_x/NO_y , and $\text{ClNO}_3/\text{Cl}_y$ observed by MkIV during balloon flights in May 1997, Dec 1999, and Mar 2000.

They illustrate substantial loss of NO_y and O_3 in the 17 - 21 km altitude range in Mar 2000 (red). The NO_x/NO_y ratio is suppressed throughout the polar stratosphere as compared with the non-vortex balloon flight (blue).

Chlorine partitioning was highly perturbed for the Mar 2000 balloon flight with ClNO_3 the predominant form of chlorine.



Status of the MkIV Gondola During SOLVE II

MkIV payload weight has been reduced from 1900 lbs to 1300 lbs since the SOLVE campaign.

MkIV gondola is flight ready and awaiting launch by CNES from Esrange.

Last possible flight date is Dec 19, 2002.

Ground-based measurements are planned for Jan – Mar, 2003, under remote control from JPL.

Additional balloon flights are being planned for Mar and Apr, 2003, for SAGE III and ILAS II validation, respectively.

FLEW: Dec 16, 2002. Successful sunrise profiles 12-32 km.

